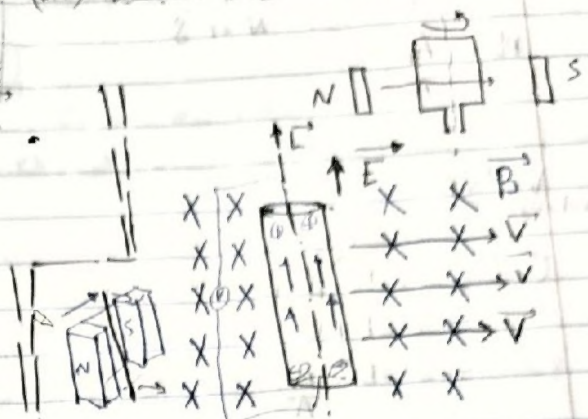
N.117

Electric rotating machine [Generator]

* e_{ind} = generated voltage

Gen Induced
Generator action $e_{ind} = (\vec{V} \times \vec{B}) \cdot \vec{L}$
cross product



$\vec{E} = V.B.\sin\varphi_{VB}$

$\varphi_{VB} = 90° \longrightarrow E = VB$

$E = \left[\frac{m}{s}\frac{V_s}{m^2} = \frac{V}{m}\right]$

E: electric field

$B\left[\frac{V_s}{m^2} = \text{Tesla}\right]$

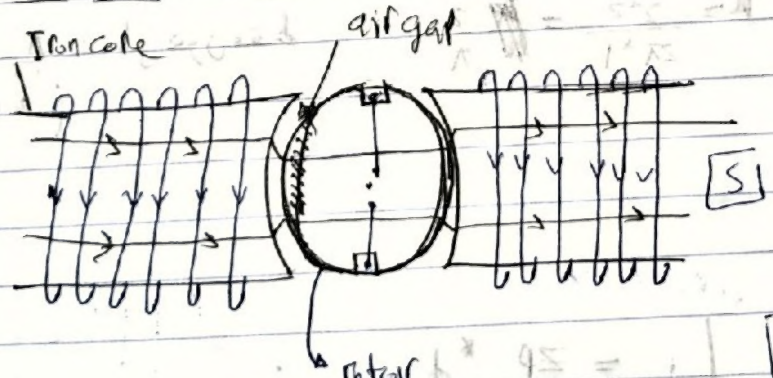
$\vec{E}.\vec{L} = E\,L\,\underbrace{\cos\varphi}_{=1}{}_{EL} = EL = \frac{V}{m} \times m = V$

$V\left[\frac{m}{s}\right]$

$q_e = -1.6 * 10^{-19}\ As$

$\vec{F} = q * \vec{E} \quad \left[As \times \frac{V}{m} = \frac{Ws}{m} = N\right]$

(⊖)



~~Retactang~~
Relactance Iron
Relactance air

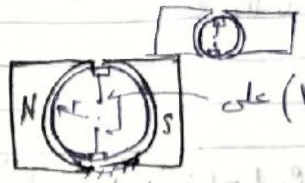
$e_{ind_T} = 2VBL$

e_{ind}
(ab): VBL (bc) $\neq 0$ (cd): V_{bL} (da) $= 0$ $\sum e_{indT} =$

$e_{ind} = 2VBL$

$A_p = \frac{2\pi rL}{2}$, area from for one side (N or S)

$rL = \frac{A_p}{\pi}$



$V = \underset{\text{velocity}}{W}r$

$e_{ind} = 2wr * B * L$

$v = 2wBrL$

$= 2wB * \frac{A_p}{\pi}$

$e_{ind} = \frac{2 * W}{\pi} * \phi$, $\left(K = \frac{2}{\pi}\right.$ machine constant depend on the geometry of the machine$\left.\right)$

$\boxed{e_{ind} = K\phi W}$

$K = \frac{ZP}{2\pi a}$

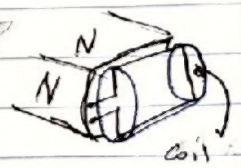
C: number of used coils

N_c: turn per coil

$Z = 2CN_c$

P: pol number

a: number of ufrent pole



$e_{ind} = \frac{ZP}{2\pi a} * \phi * W$

$Z = 2 * 1 * 1 = 2$, $K = \frac{2*2}{2\pi*1} = \frac{2}{\pi}$ عشان هون فقط $\frac{A}{2}$ لعـ

$P = 2$, $a = 1$ (coil 1

$\boxed{e_{ind} = K\phi W}$

$e_{in} = K * \phi * \frac{2\pi n}{60}$

$= \frac{ZP}{2\pi a} \times \phi * \frac{2\pi n}{60}$

$= \frac{ZP}{60a} * \phi n$

$\boxed{e_{ind} = K'\phi n}$ $\boxed{K' = \frac{ZP}{60a}}$

Commutator = mechanical rectifier two contacts (Brushes)

* الـ Voltage بطلع AC ولكن بستخدموا commutator بعلب عند كل دورة فبطلع عنا تقريباً (DC Volt)

$$\theta_e = \frac{P}{2}\theta_m \quad \text{(Pole)}$$

$P = 2$ pole $\rightarrow \theta_e = \frac{2}{2}\theta_m = \theta_m$

* Theta mechanic (θ_m) هي الدورة الواحدة الكاملة فيزيائياً

$P = 4$ pole $\rightarrow \theta_e = \frac{4}{2}\theta_m = 2\theta_m$

* يعني كل دورة بتتغير الـ Voltage مرتين

* (θ_e) هي الدورة الواحدة أو الموجة الواحدة لـ Voltage

$W_e = \frac{P}{2} W_m$	$f_e = \frac{P}{2} f_m$	$T_e = \frac{2}{P} T_m$	$W_e = \frac{P}{2} * \frac{2\pi n}{60}$
$W_e = \frac{P}{2} 2\pi f_m$	$\frac{1}{T_e} = \frac{P}{2}\frac{1}{T_m}$	$P = 2 \rightarrow T_e = T_m$	$2\pi f_e = \frac{P}{2} * \frac{2\pi n}{60} \rightarrow f_e = \frac{P}{1}$
	$P = 4 \rightarrow T_e = \frac{2}{4} T_m = \frac{1}{2} m$		$120 f_e = nP$

الجزء الأساسي
أساسي / طاقة كهرومغناطيسية

Rotor is the armature in the DC machine :

$T = K \phi I$

$W T = P_{out}$

$\frac{2\pi n}{60} * T = P_{out}$

$T = \frac{P_{out}}{(2\pi n/60)}$

$Q_{ele} = \frac{P}{2} * Q_m$

if $P = 12 \rightarrow$

$Q_{ele} = \frac{12}{2} * Q_m$

$= 6 Q_m$

$Q_m = 360° \rightarrow Q_{ele} = \frac{360}{6} = 60°$

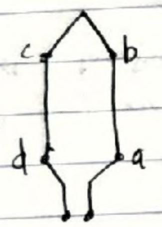
$e = K \phi w$

$= K' \phi n$

$e_{out} * I_{out} = P_{out}$

$I_{out} = I_{Load} = \frac{P_{out}}{e_{out}} = \frac{P_{out}}{e_{in}}$

Armature Windings :



* الـ effective هو (a-b) و (c-d)
* الباقي يكون خارج المجال المغناطيسي

1 coil   turn per coil

$C = 1 \quad N_c = 3$

$Z = 2 C N_c$

$Z = (2)(1)(3) = 6$ conductors

$c = 1$ (coil), $N_c = 1$ (turns) : $Z = 2(1)(1) =$

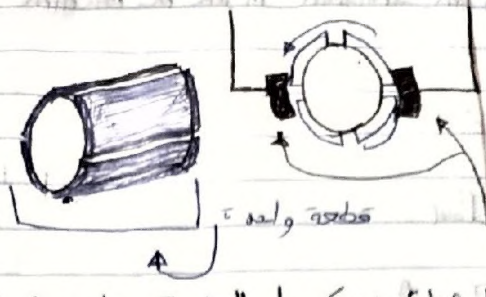
$= 2$ conductors

[(a-b)(c-d) are conductors]

- Windings types Of Rotor Coils :

1 - Lab windings

2 - Wave Windings



* بس بيدور الـ rotor بيعكسوا القطبية عشان يعطينا Dc

[Lab Winding]

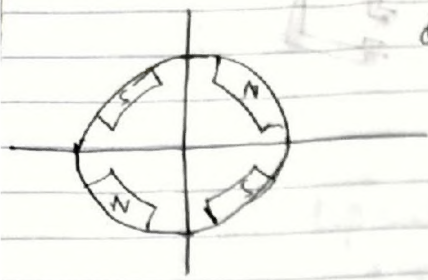
Lab winding : a = P

For low Voltage and hight current machine

أظن صورت رسمة زي هاي * الـ wave
بس دكتورنا بعادس البعض على الآخرين

N.[2] بينا [1:30] كان في امتحان

Pol Pitch 180° elect



$\theta_{ele} = \frac{P}{2} \theta_m$

$W_e t = \frac{P}{2} W_m t$

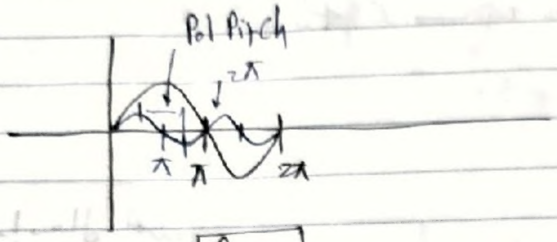
$2\pi f_e = \frac{P}{2} 2\pi f_m$

$T_m = 2T_e$

$\frac{1}{T_e} = \frac{P}{2} \frac{1}{T_m}$

$P = 4 \rightarrow \frac{1}{T_e} = \frac{2}{T_m}$

$T_m = 2T_e$



[P = 4]

Pol Pirch 180° elect $= \frac{360°}{P}$

$P = 2 = 180°$ ele $= \frac{360}{2} = 180°$

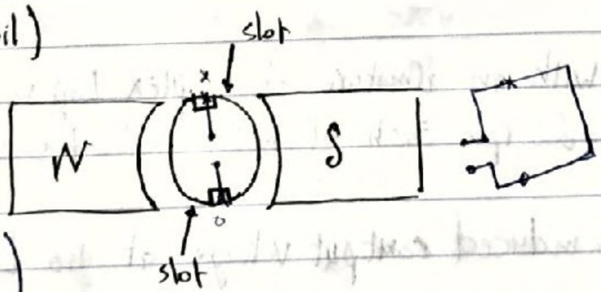
$P = 4 \Rightarrow 180°$ ele $= \frac{360}{4} = 90°$

$P = 12 \Longrightarrow 180$ ele $= \frac{360}{12} = 30°$

بكون الـ θ_m من 90 زاوية يعني عكوه
هو الـ Pol Pith ← هو المسافة بين قاع وقاع
قمة وقمة
قمة وقاع ∩ or ∪ or ∿

[Rotor Coils]
(ARmatur coil)

[Single Layer winding]

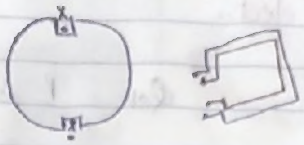


(1 coil Per slot, whatever it was the umper of turns)

[$C = \frac{1}{2} S_n$, $S_n = 2 \rightarrow C = 1$]
(coil number, slont number)

[Dopple Layer Winding]

[2 coil per each slot whatever was number of turns]



coil number
$C = S_n$
slot number

$Z = 2 C N_c$

$S_n = 2 \longrightarrow C = 2$
$S_n = 40 \longrightarrow C = 40$

$N_c = 8$ turns
$Z = 2 \times 40 \times 8 = 640$ conductors

[Wave Windings]

Simplex wave winding: $a = 2$

doublex wave winding: $a = 2m$, $m = 2 \longrightarrow a = 4$

~~poles~~

$m = 4 \longrightarrow a = 2^* 4 = 8$ paths or ~~parts~~

Ex: DC generator with an armature of simplex Lap winding. It has 8 slots 2 poles, driven at $n = 600$ rpm each of Rotor coils has 3 turnes the flux $\phi = 0.25$ Vs

: Determine the induced output voltage at no Load

slot number $S_n = 8$
poles $P = 2$
$n = 600$ rpm
turn per coil $N_c = 3$ turns
flux $\phi = 0.25$ VS

* Simplex Lap winding ($a = p$: path = poles) $\Longrightarrow$ 2 poles = 2 paths
* single Layers winding $\Longrightarrow$ 8 slot $\Longrightarrow$ 4 coil
single = coil per 2 slots

$Z = 2 C N_c = 2^* 4^* 3 = 24$ conductors

Simplex Lap Winding $a = p$ (path, poles) number of path = number of poles

doublex Lap winding $a = mp$, $m=3$

$m=2 \rightarrow a = 2*p$, $p=2 \rightarrow a=4$

Triplex Lap winding $m=3 \rightarrow a = 3*p$

Quadretlex Lap winding $m=4 \rightarrow a = 4*p$

إنتقال الصفحة الباقية

أعمال طرق — نعتمد على الإزاحة

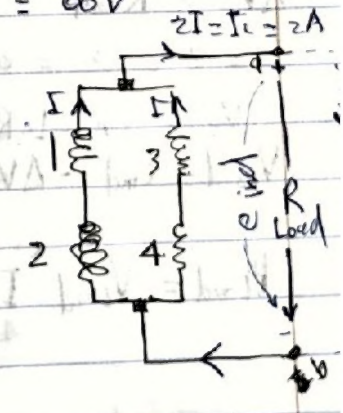
يتزحلقون

$\frac{24 \text{ cond}}{8 \text{ slot}} = 3 \text{ cond/slot}$

Lab winding

$e_{ind} = \frac{ZP}{2\pi a} \phi w = \frac{ZP}{2\pi a} \phi \frac{2\pi y}{60}$

$= \frac{ZP}{600} \phi y = \frac{24*2*0.25*600}{60*2} = 60V$



2 paths
4 coils

[b] if the generator is Loaded by 2A determine the output power given by the generator

$$P_{out} = e_{ind} * I_L = 60 * 2 = 120 \text{ W}$$

* my solution

$$P_{out} = I_A * V_T \quad , \quad V_T = E_A - I_A R_A = 60 - (2)(R_A) \qquad P_{out} = I_A * V_T$$

[c] what is the induced torque with respect to [b]

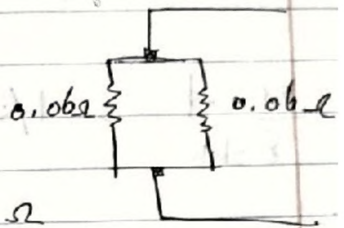
$$T = K \phi I = \frac{ZP}{2\pi a} \phi I = \frac{24 * 2}{2\pi * 2} * 0.25 * 2 = 1.9 \text{ N/m}$$

Resistance

[d] if each turn has $R_{turn} = 0.01 \Omega$
Determine the power consumed by the load

$R_{turn} = 0.01 \Omega$

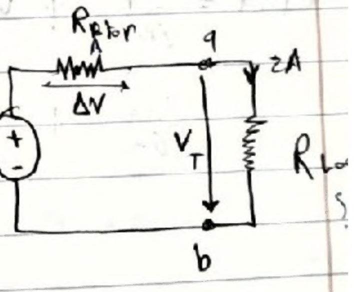
$R_{coil} = 3 * 0.01 = 0.03 \Omega$



$R_{branch} = R_{2 \text{ coils in series}} = 2 * 0.03 = 0.06 \Omega$

* لنا 2 path فا رجعنا المقاومة لكل واحد لكل فرع branch

$R_{rotors\ total} = \frac{1}{2} * 0.06 = 0.03 \Omega$



$\Delta V = 2 * R_{rotor}$

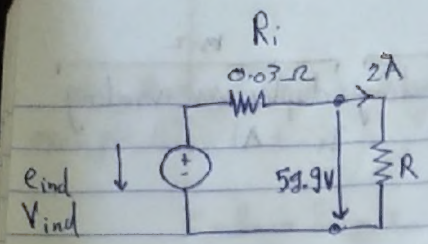
$= 2 \; 0.03 = 0.06 \text{ V}$

$V_T = E_A - I_A R_A$

$V_{Load} = e_{ind} - \Delta V = 60 - 0.06 = 59.94 \text{ V}$

$$P_{Load} = V_{Load} * I_{Load} = 59.94 * 2 = 119.88 \text{ W}$$

أقل



$V_T = I_{Load} R_{load}$, $R_{Load} = \frac{V_T}{I_A}$

$R_L = \frac{59.94}{2} = 29.97\ \Omega$

Example: Wave Winding Rotor of a DC generator (simplex wave), $\phi_u = 0.25$ V

$n = 600$, $P = 2$ poles , each coil has 3 turns

8 slots ($n_s = 8$) Single

$e_{ind} = ?$ $q = 2$

$a = 2$ (wave winding simplex) , $C = \frac{1}{2} S_n = \frac{1}{2} * 8 = 4$ coils

$Z = 2C * N_c = 2 * 4 * 3 = 24$ conductors

$a = 2 \rightarrow \frac{24}{2} = 12$ cond/path

$C = 4 \rightarrow \frac{C}{2} = 2$ coil/path

1 coil $= 2C N_c = (2)(1)(3) = 6$ conductors

$$e_{ind} = \frac{ZP}{2\pi a} * \phi * w = \frac{ZP}{2\pi a} * \phi * \frac{2\pi n}{60} = \frac{ZP * \phi * n}{600} = \frac{24 * 2 * 0.25 * 60}{60 * 2}$$

$= 60$ V

$R_{turn} = 0.01\ \Omega$ $R_{rotor} = \frac{1}{2} 0.06 = 0.03\ \Omega$

$R_{coil} = 3 * 0.01 = 0.03\ \Omega$

$R_{branch} = 2 \times 0.03 = 0.06\ \Omega$